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European Money Demand and the Role of UK for its Stability: A Cointegration Analysis

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Abstract

This paper develops equilibrium correction models for money demand of European-wide broad monetary aggregates based on a multivariate cointegration analysis. It will be shown that whether or not the UK *is* a member of a monetary union does not affect the empirical stability of area-wide money demand models. However, there is evidence that the properties of a money demand model for an area that previously did not include UK might change just when the UK will join the union: The models' dynamics and the super-exogeneity status of output are different in models that do contain UK in their areas compared with those which do not.

JEL classification: C3, C5, E4, E5.

Keywords: Area-wide European Money Demand, Cointegration, Parameter Stability, Super Exogeneity.

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1 Introduction

In this paper I will estimate and discuss empirically stable money demand equations for area-wide broad monetary aggregates in Europe. As well as for any domestic monetary policy a stable money demand function is also necessary for the conduct of a common European monetary policy if a monetary aggregate is targeted. A joint monetary policy for a Single European Currency will be operated by the future European Central Bank (ECB) most probably from January 1999 on. As it is the current situation in early 1998 it seems highly probable that from the "Big Four" (Germany, France, Italy and UK) only the UK will not join the European Monetary Union (EMU) in 1999. This paper develops econometric money demand models for European-wide broad monetary aggregates under particular consideration of the role of UK. It will be shown that whether or not the UK *is* a member of a monetary union does not affect the empirical stability of area-wide money demand models. However, this paper also provides evidence that the properties of a money demand model for an area that previously did not include UK might change just when the UK will join the union: The models' dynamics and the exogeneity status of its explanatory variables are different in models that do contain UK in their areas compared with those which do not. Models will be estimated for a small group of countries by comparing aggregated money demand models for the "Big Four" with and without UK; and for a larger group of ten countries with and without UK. In all four cases empirically stable, economically meaningful, and statistically well specified aggregated Equilibrium Correction Models for corresponding area-wide money demand will be presented. The models will be developed based on a multivariate cointegration analysis. The data are quarterly over the sample period 1983(1) - 1996(4).

An obvious methodological problem for the economic and econometric conclusions to be drawn from the empirical models lies in the fact that the models will be developed based on historical data from a different regime and as a composition of individual countries. However, a future European Central Bank will be facing exactly this problem when decisions about monetary policy have to be made from the very beginning of EMU. Neither will it have a credibility record such as e.g. the Bundesbank, nor will there be any data available which could serve to build an empirical benchmark model of the new regime. It therefore seems appropriate to understand area-wide empirical studies such as the one presented here as an (even possibly crude) approximation of a regime for which no data is available.

On the other hand the European Monetary System (EMS) in the period from 1983 onwards might be seen as representing a fairly stable monetary regime with a few important and probably non-controversial stylized facts. First, the EMS has operated as an asymmetric monetary system with the Bundesbank playing the role of the leader and the Deutschmark being the nominal anchor of the system. Second, since the removal of capital controls in the early 80's (except France and Italy where they were removed in 1989/90) there was a high degree of capital mobility. Third, the exchange rate mechanism (ERM) has established over most of the time a system of comparatively stable exchange-rates in particular after the Basle-Nyborg agreement in 1987 (with exception of the speculative crises at the beginning of the 90's.). Fourth, from 1983 on the differentials of long-term interest rates between Germany's and most of the EMS countries' bond rates have decreased significantly. The same applies for inflation differentials in particular of former high-inflation countries such as Italy and Spain with respect to Germany. Accepting these stylized facts it might then be argued that an empirical model which is based on data of that period is not such a bad approximation for a common monetary union.

In the ongoing research on area-wide money demand models there are two issues of particular interest: currency substitution and the aggregation problem. In most of the existing literature it is found that area-wide money demand is more stable than in individual countries. A widespread explanation for that phenomenon is that nonbanks hold their money in different (European) currencies and substitute them in response mainly to exchange rate expectations. Hence individual domestic monetary aggregates are less predictable than an area-wide one. This therefore implies a benefit of area-wide money demand functions: the control of an area-wide monetary aggregate by the ECB could be operated more effectively than in the individual countries by the corresponding national Central Banks, which due to external influences have only limited control over domestic (monetary) variables. Furthermore, following a conventional strategy of monetary policy the ECB could then possibly target an area-wide monetary aggregate by appropriately using its monetary tools, i.e. short-term interest rates. This is of particular interest with respect to the current academic and political discussion on the strategical concept of monetary policy which the ECB should pursue: either to take over the Bundesbank's monetary policy with its strategy of targeting a broad monetary aggregate as intermediate target to reach price stability as the exclusive final target; or to use an inflation target, e.g. based on inflation forecasts. As it is noted by the EMI (1997) "the long-term stability on money demand in the Euro-area is a crucial factor determining the effectiveness and scope of monetary targeting". Therefore a stable (even though approximative) European money demand function is at least a necessary condition for targeting a European-wide monetary aggregate. However, reasons for this not to be a sufficient condition include both economic and econometric shortcomings which manifest the costs of estimating area-wide money demand models. Aggregation bias may be induced by the construction and estimation of a function of area-wide variables. Moreover, even if a stable econometric model is estimated, if that model is subject to the Lucas critique after the new regime of a common monetary policy is implemented in 1999 it might lose its empirical stability. It is therefore of paramount importance to test for exogeneity and misspecification of estimated European money demand models to be developed below.

The contribution of this paper to the empirical literature is twofold. Firstly, equilibrium correction models based on the multivariate cointegration estimation technique developed by Johansen are estimated. The empirical stability of the estimated parameters of the long-run money demand function is shown by applying the recently developed recursive estimation technique for non-stationary variables by Hansen and Johansen (1996). Taking into account the presence of dummy variables in the cointegrating process critical values for the trace test for testing the dimension of the cointegration space are simulated by using the software program DisCo 1.4 (see Johansen and Nielsen, 1997). Secondly, the theoretically not appealing aggregation of the different national interest rates by a weighting scheme is avoided. Instead, assuming a stable link between German and other European countries' interest rates to hold only German interest rates are used. This is based on the argument that during the EMS the Deutschmark was the nominal anchor of the currency system such that all relevant information about own rate and opportunity costs of holding even an area-wide aggregate are contained in the German interest rates, together with the Deutschmark - US Dollar exchange rate.

The remainder of the paper is organized as follows. Section 2 provides a background on area-wide European money demand issues such as the underlying theoretical long-run money demand function; the choice of selected countries and the definition of different areas; and aggregation and conversion issues on area-wide aggregated variables. Section 3 presents the data and in Section 4 the empirical econometric models for four different European areas are estimated and statistically evaluated. Section 5 provides an economic interpretation of the empirical results and applies tests for super-exogeneity for some of the explanatory variables to test for the relevance of the Lucas critique with respect to the estimated models. Section 6 presents the main results and the data are documented in the Appendix.

2 Area-Wide Money Demand: The background

Since the pioneering empirical research on European money demand by Bekx and Tullio (1989) and Kremers and Lane (1990) several other studies subsequently appeared in the literature such as those by Artis *et al* (1993), Monticelli and Strauss-Kahn (1992), Fase and Winder (1992), Fagan and Henry (1997) and Monticelli and Papi (1996). The latter reference also provides an excellent survey over various theoretical and technical issues related to European money demand. The different studies often vary in the composition of the areas by including different groups of countries; the aggregation methods; the character of the monetary aggregate (narrow or broad) under consideration; the sample period; and the econometric approach. However, to some extend they all provide evidence that an empirically stable money demand function for an area-wide European aggregate can be found.

2.1 An Area-Wide Theoretical Money Demand Function

In this paper area-wide European money demand will be analyzed for a broad monetary aggregate. The choice was motivated by monetary policy considerations. If the ECB will pursue monetary targeting *á la* Bundesbank the intermediate target will most probably not be a narrow aggregate but rather a broader aggregate corresponding e.g. to German M3. Moreover, the resulting models and their properties can then directly be compared with Beyer's (1998*a*) money demand model for German M3. Similar to the specification there the European money demand model for a broad monetary aggregate to be developed here is based on a conventional long-run specification such as

$$(m-p)^{Ej} = \beta_0 + \beta_1 y^{Ej} + \beta_2 RS^{Ej} + \beta_3 RL^{Ej} + \beta_4 \Delta p^{Ej} + \beta_5 ex. \tag{1}$$

Real balances are a function of real income (y); short-term (RS) and long-term (RL) interest rates variables and inflation (Δp). RS represents an own rate, RL and Δp opportunity costs of holding money. The exchange rate variable (ex) captures out-of-area currency substitution effects. Superscript Ej indicates a European aggregate composed of j countries to be specified now. Small letters denote here and elsewhere logs.

2.2 The countries to be selected

Apart from technical difficulties mainly caused by limited data availability the choice of countries is influenced by economic reasoning which in turn is linked to the choice of the sample period. Currently there are fifteen countries members of the EMS: Austria (AUT), Belgium (BEL), Denmark (DK), Finland (FIN), France (FRA), Germany (GER), Greece (GR), Ireland (IRL), Italy (ITA), Luxemburg (LUX), Netherlands (NL), Portugal (POR), Sweden (SWE), Spain (ESP), and United Kingdom (UK). Together with the non-members Norway (NOR) and Switzerland (CH) this group of seventeen countries might constitute the largest potential set.

The selection process of countries requires decision rules on the following criteria:

- Should a country be member of the EMS, and if yes does it have to be member over the whole sample period?
- Should a country be member of the ERM, and if yes, over the whole sample period?
- Should those countries be selected which have pegged their currencies to the ECU (or a comparable basket) or to the DM?
- Which sample period should be chosen? Is it sensible to include the highly unstable pre-1983 period with several exchange rate realignments?

Since the empirical model to be developed here should be able to help predicting the consequences of the ECB's monetary policy the first selection criterion is determined by the list of countries which are in theory a potential candidate for joining the monetary union. Hence EMS membership is required yielding the exclusion of NOR and CH. If membership over the whole sample period would be required this would either shorten the sample period intractably or it would exclude several countries which more recently have joined the EMS (e.g. FIN and SWE). Therefore the criterion chosen is the EMS membership at the end of the sample period. Concerning ERM membership, similar arguments apply as with EMS membership so ERM membership is not required over the whole sample period. Moreover, since UK is strongly preferred to be selected in the model but is not an ERM member anymore after joining only in 1990 and leaving two years thereafter together with Italy, ERM

Aggregate Ej	Countries
E3	FRA, GER, ITA
E4	FRA, GER, ITA, UK
E9	FRA, GER, ITA, BEL, DK, ESP, FIN, NL, SWE
E10	FRA, GER, ITA, BEL, DK, ESP, FIN, NL, SWE, UK

Table 1: The areas

Country	FRA	GER	ITA	BEL	DK	ESP	FIN	NL	SWE	UK
Monetary aggregate	M3	M3	M2	M3H	M2	M3	M2	M3	M3	M4

Table 2: National monetary aggregates

membership was skipped altogether as a criterion. Finally, for the sample period there are in principle two candidates for a starting period. Either 1979 with the beginning of the EMS or 1983 if the unstable pre-1983 period should be excluded. For several European countries (not for Germany though) it has been shown in the literature that national money demand was severely destabilized during the pre-1983 period. Juselius (1997) e.g. analyses monetary transmission mechanisms for DK, GER, ITA and ESP and finds strong evidence for a structural break in 1983 due to capital liberalization. Moreover, there have been several realignments between 1979 and 1983 with potentially distorting effects on the aggregation of national variables when they are converted into a single currency aggregate (see below). On the other hand for several countries a complete data set for the pre-1983 period is not available. Therefore it was decided that the sample period starts from 1983 onwards. Nevertheless, for some countries there is no complete data set available even from 1983 onwards. These are IRL, POR and GR. For AUT there is no broad monetary aggregate available. However, these countries together have 1996 a nominal GDP share of less than 6% and hence their exclusion should not have a major impact on the empirical results. Finally, LUX is not included but it maintains a currency union with BEL. Hence the largest set contains ten countries forming the E10 aggregate as listed in Table 1. From the "Big Four" economies FRA, GER, ITA and UK which have a share of more than 70% in the EU (measured either by GDP, broad money stock or ECU-basket shares) the UK is most probable the only country which might not join the union from the start but might join later. One of the motivations of the empirical analysis is to investigate the role of UK with respect to the stability of an area-wide European money demand model. Therefore I will present empirical models for four different area compositions. E9 excludes UK from E10 and E3 excludes UK from the "Big Four" area E4. The dependent variable of the area-wide money demand model is a sum of the national countries' broad monetary aggregates after converting them into units of Deutschmark. The aggregates are listed in Table 2. With regard to the area-wide aggregation the different national concepts of *domestic* money holdings appear to be fairly homogenous (see e.g. Monticelli and Papi (1996) for technical details). In contrast, methodological problems arise from the existence and different treatments of "Cross Boarder Deposits" (CBD's) in national aggregates.

CBD's are characterized by the non-coincidence of i) residence of holder, ii) currency of denomination, and iii) the location of the financial intermediary. If different conceptual treatments of foreign capital and their holders apply at the national level, this might either yield too small or too large European aggregates (see e.g. Angeloni *et al,* 1994). Monticelli and Papi (1996) estimate European money demand functions which do incorporate extended aggregates for several types of CBD's. As important results they find that the estimated models with CBD's included do not differ massively with respect to its dynamic and statistical properties from those with conventional money aggregates. Moreover "models with extended aggregates never outperform the traditional definition of money, which consequently remains the preferred monetary aggregate". Based on these empirical findings and since data on CBD's is only available to a limited extend the European money demand models in this paper are based on the conventional national aggregates as listed in Table 2.

2.3 Aggregation and conversion methods

To construct area-wide aggregates of the variables involved in the analysis the two fundamental conceptual issues are: the conversion of the individual domestic nominal variables into variables with homogeneous units that can be added up; and an appropriate measure for area-wide interest rates and goods prices.

2.3.1 Area-wide money stock and output

For conversion of the nominal variables there have been in principle three different methods with subcases applied in the literature. In most of the studies nominal variables are converted either by market exchange rates or by PPP exchange rates. In both cases either current or fixed exchange rates of a base-line period can be used. The third method which is applied by Bayoumi and Kenen (1993) uses an index based on the weighted aggregation of domestic growth rates which can then be cumulated to level variables. If certain conditions are fulfilled some of the methods are equivalent. If exchange rates are continuously consistent with PPP the current exchange rate and current PPP rate method produce the same results. The fixed exchange rate method corresponds to the current PPP rates method if all countries involved had identical inflation rates. The different conversion methods which have been used in the literature are not uncontroversial. Monticelli and Strauss-Kahn (1993) and Monticelli and Papi (1996) convert nominal variables by current market exchange rates. They argue that this is consistent with a view that money balances are demanded, both for transaction and store-of-value purposes and that current and future purchasing power, in terms of foreign goods and assets, is appropriately measured by market exchange rates. Kremers and Lane (1990) on the other hand claim that the results obtained by Bekx and Tullio (1989) using a fixed baseline-period exchange rate are not valid because this method yields a not well specified money demand function due to parameter instability. Kremers and Lane favor PPP conversion rates because they reflect the purchasing power of the individual countries' currency *vis-a-vis* the currency into which the aggregates are converted. Hence the weight of each country in the area-wide aggregates reflects the size of its real economy and the growth rate of the area-wide real variables reflect the growth rates of the corresponding national variables. Fagan and Henry (1997) use a fixed base-line period PPP exchange rate. They point out that in this case area-wide real variables are exactly equal to the weighted average of corresponding national variables. However, applying this method and comparing their models with those obtained by the current exchange rate method they get "generally similar results". The same applies to the findings by Monticelli and Strauss-Kahn and Monticelli and Papi. They find that when comparing the money demand functions based on current exchange rate and PPP rate conversion the same fundamental conclusions about their money demand models hold. Monticelli and Strauss-Kahn (1993) find that over their sample (1977-1990) departures of current exchange rates from PPP rates are relatively small for all EMS countries except for UK and to a lesser extent Spain. Artis *et al* (1993) on the other hand defend the use of fixed period exchange rates. Referring to the difficulties in constructing PPP exchange rates and underlying assumptions about PPP which are often violated in reality they stress the advantage of "the ease" with which the fixed period exchange rate method can be applied. However they admit that the disadvantage of that method lies in the arbitrary choice of the base-line period. The intensive discussion on this issue in the literature has not proven one method to be analytically superior over another one so it is rather a matter of convenience and taste which leads to the choice of one or another method. In this paper I will follow the "market forces" argument put forward by Monticelli and Strauss-Kahn (1993) and apply the current exchange rate method for the conversion of national money stocks and GDPs.

2.3.2 Aggregate price and interest rate variables

Virtually all of the studies on European money demand use area-wide price variables (goods prices and interest rates) based on a weighting scheme which takes into account the economic size of individual countries. Weights are constructed either by individual countries' shares in the area-wide aggregates of money or output or according to the shares of a country's currency in the ECU currency basket. From a theoretical point of view the aggregation of price variables (goods price indices and interest rates) is not straightforward and a weighted average of goods prices or interest rates is hardly a general equilibrium solution as can be seen e.g. in the analysis of a two country model by Lucas (1982) who develops equilibrium conditions for prices and interest rates for various modelling environments (barter versus monetary economies; and fixed versus flexible exchange rates both in a world with two domestic currencies). Equilibrium-prices and interest rates are derived from first order conditions of utility maximization with respect to budget constraints and endowments. Especially constructing weighted averages of interest rates is problematic in an environment of optimizing agents. With regard to the role of interest rates as representing opportunity costs in a money demand function for M1 Baba, Hendry and Starr (1992) derive optimality conditions for agents' utility maximization with respect to money and equity holdings. Assume that the interest variable RL represents a certain range of different alternative assets to money (in the case of a broad aggregate under consideration here the assets are outside M3 such as e.g. equities and bonds). When interest rates represent opportunity costs on holding money then Baba *et al* show that (risk-adjusted) yields on alternative assets might differ from their average values. They argue that for optimizing agents the maximal opportunity cost and the maximal own rate of a range of assets are the relevant marginal rates. Therefore a weighted sum of a range of assets' interest rates specified as an "artificial" interest rate variable in a money demand function does not represent marginal rates of substitution. Baba *et al* recommend to implement a max-algorithm for interest rates such that in each period only the asset's interest rate with highest return enters the corresponding interest rate variable. However, for an area-wide European money demand function it might not be a good advise to use this approach for risk-unadjusted interest rates due to very different risk properties among the same categories of assets. Comparing e.g. a German and Italian government bond with the same maturity then a 10% yield, say, on the Italian bond might not necessarily be the maximal opportunity cost when comparing with a, say, a 5% yield on a German bond. Instead, a different approach is pursued in this paper. I will use only German interest rates as representative interest rates for European money demand. This is based on the widely accepted fact that the Deutschmark was the nominal anchor during most of the EMS period and that the EMS has worked in an asymmetric way (see e.g. Giavazzi and Giovannini (1989) or De Grauwe (1989) for a detailed theoretical and empirical treatment of this issue). Different measures of asymmetry of a monetary system have been suggested in the literature and applied with regard to the functioning of the EMS. The most important feature for the argument pursued here is that interest rates within the EMS have mostly reacted asymmetrically. German short-term interest rates have largely been under control of the Bundesbank whereas other European interest rates have either adjusted to German monetary policy actions and/or to changes in exchange rates (expectations) *vis-a-vis* the DM. To analyze the role of the German interest rates for the European area consider a model environment similar to that in McKinnon (1982) who investigates the role of world interest rates with regard to US money demand. I will transfer McKinnon's model such that Europe corresponds to "the world" and Germany plays accordingly the role of the US. Therefore let us assume for a moment a European economy ("EUR") which is in terms of interest rates and exchange rates independent from the rest of the world. Assume furthermore free goods and capital markets and a "perfect" bond market in EUR such that agents are indifferent between German bonds, any other national bond from the rest of EUR or EUR bonds itself after taking exchange rate expectations into account. Hence the uncovered interest parity (UIP) condition is assumed to hold. Assume that the interest rate on the EUR bond, R^E represents opportunity costs in the European money demand function

$$(m-p)^E = f(R^E, Y^E, \bullet). \tag{2}$$

As in McKinnon's model I assume as a first approximation that exchange rate expectations do not affect EUR money demand but they do affect national money demand functions as well as R^E. Denoting s an expected depreciation of the value of Deutschmarks then German interest rates on bonds (R^{GER}) and bond rates in the "rest of EUR" (R^{roE}), are assumed to be influenced by s such that

$$R^{GER} = R^E + (1-\alpha)s \tag{3}$$

$$R^{roE} \quad = \quad R^E - \alpha s \tag{4}$$

where α represents the "financial weight" of GER in the EUR capital market. Given the asymmetric functioning of the EMS with the DM being the nominal anchor and the Bundesbank acting as leader it seems plausible to assume α to be close to one. According to (3) and (4) this implies R^{GER} to be very close to R^E such that an expected change in the value of DM has only a modest impact on the German bond rate whereas on the other hand the interest rate in the rest of EUR adjusts almost fully. Hence, if the DM is expected to appreciate R^{roE} increases - a phenomenon that has been observed quite often during the EMS period. It might therefore be plausible to approximate R^E by the German rate R^{GER} such that (2) becomes

$$(m-p)^E = f(R^{GER}, Y^E, \bullet). \tag{5}$$

I relax now the initial independence assumption of EUR not being influenced by monetary conditions of the rest of the world. Therefore taking into account that currency substitution to out-of-EUR currencies might affect EUR's money demand function would suggest to add an exchange rate variable to the model such that (5) becomes

$$(m-p)^E = f(R^{GER}, Y^E, ex, \bullet) \tag{6}$$

with the DM-US Dollar exchange rate being an obvious candidate for ex_t.[1]

For the construction of a suitable European price variable there exist basically two possibilities. Since the national nominal variables will be converted in Deutschmark the question is whether the area-wide aggregates are to be deflated by a weighted price index as it is the common method applied in the literature or if the theoretically more appealing way of deflating by the German price index can be applied. For the latter method it is necessary that PPP holds between Germany and the other countries contributing to the aggregate. PPP therefore plays a similar role for the price index as UIP does with respect to the decision to use German interest rates as an approximation for European interest rates. From the results of the empirical analysis for testing PPP and UIP within a cointegration framework Beyer (1998*e*) concludes that PPP does not hold between Germany and most European countries whereas UIP or at least a systematic link between German interest rates and European interest rates can be assumed to exist. Hence, an area-wide weighted European price index will be used.

3 The data: Construction of area-wide aggregates

To construct area-wide aggregates of nominal money from domestic money stocks as listed in Table 2 and of output from national nominal GDP series the corresponding

[1] As documented in Deutsche Bundesbank (1995) in the currency structure of German foreign trade (in 1992) the US Dollar has the highest share of all foreign currencies (7.3% w.r.t. exports and 18,4% w.r.t imports). The Japanese Yen has only the second highest non-EMS currency share (0.6% w.r.t exports and 1,7% w.r.t. imports).

domestic raw variables in levels are first converted into DM units by multiplying with current DM exchange rates EX_t^i such that

$$\begin{aligned} M_t^{Ej} &= \sum_{i=1}^{j} EX_t^i M_t^i \\ Y_t^{Ej} &= \sum_{i=1}^{j} EX_t^i Y_t^i \ , \ j = 3;\ 4;\ 9;\ \text{and}\ 10 \end{aligned}$$

and thereafter the area-wide aggregates M_t^{Ej} and Y_t^{Ej} are expressed in logs m^{Ej} and y^{Ej}, respectively. Figure 1 shows for the four areas the logs of these nominal

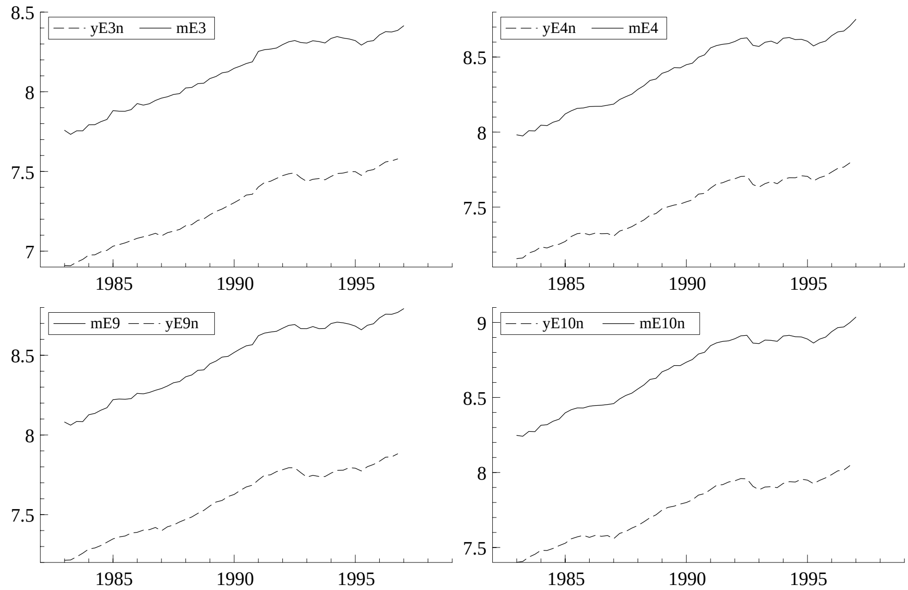

Figure 1: European aggregates of nominal GDP and broad money (logs of sums)

aggregates. Next, for each of the four areas the aggregated price index is defined as the sum of weighted domestic price indices (i.e. domestic GDP deflators)

$$P_t^{Ej} = \sum_{i=1}^{j} w_t^{Eji} P_t^i,\ j = 3;\ 4;\ 9;\ \text{and}\ 10$$

where w_t^{Eji} are current weights of country i's share in corresponding area-wide nominal GDP. Note that for aggregation domestic GDP deflators are required to be based on the same year, so some of the raw series had to be re-based to the common base year 1991. Table 3 shows the percentage share of each country's nominal GDP converted in current period DM within the E10 aggregate for the first and last observation in the sample period and Figure 2 shows the weights over time. Two events had a particular impact on the weights: The first one in 1991.1 when German unification has shifted German GDP share upwards, whereas the ones of FRA, ITA, and UK

	GER	FRA	ITA	UK	ESP	NL	BEL	SWE	DK	FIN
1996.4	28.6	18.9	15.2	15.1	7.1	4.8	3.2	3.3	2.1	1.6
1983.1	24.9	20.8	15.5	17.1	6.2	5.3	3.1	3.4	2.2	1.6

Table 3: Percentage GDP shares in nominal E10-GDP

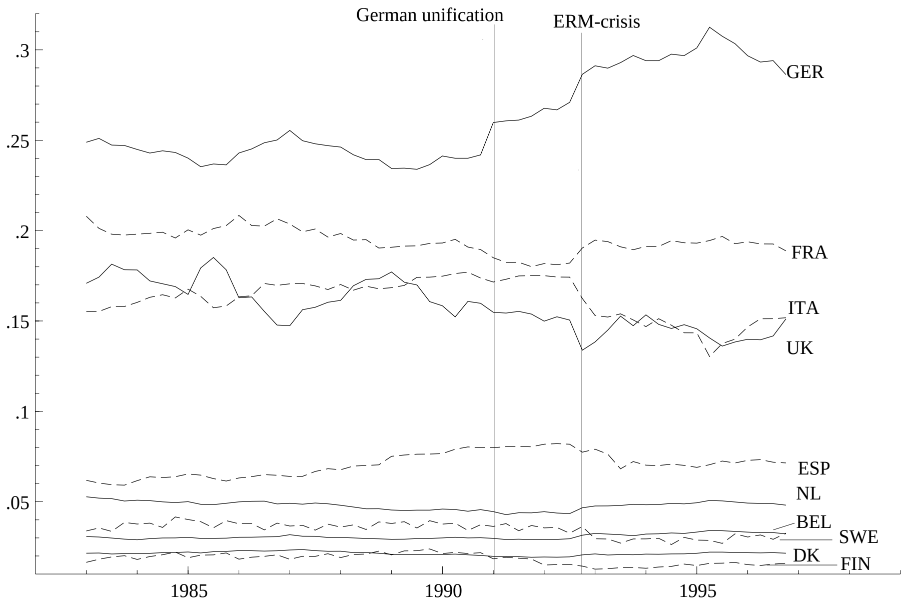

Figure 2: nominal GDP shares in aggregated E10-GDP, converted by current DM rates

fall rather smoothly; and the second one at the ERM-crisis in September 1992 when German and French exchange rates appreciated and the Italian Lira and the British Pound depreciated (and left the ERM). Clearly the first event reflects a "real" increase in German weights (the German economy grew by around 10% due to unification) whereas the increase in weights in 1992 is probably not related to the real economy.[2] It is due to the strong movements in currency markets caused by speculative attacks and clearly shows the limits of the "market-forces" argument which has motivated the conversion by current exchange rates. Figure 3 shows the annualized German and weighted area-wide inflation rates. The German inflation rate is consistently lower than the European aggregates during the eighties but is higher in the first half of the nineties. Furthermore, the graphs show that during the nineties the inflation differential between Germany and Europe has reduced remarkably.

Finally area-wide nominal GDP and money stock are deflated by the corresponding area-wide price index. Figure 4 shows the growth rates of real GDP and real

[2] This depends on how the speculative attacks in 1992 are interpreted. If the exchange-rate changes are seen as a "return" to exchange rates which are consistent with economic fundamentals and which the ERM has avoided to happen before, then the exchange rate crisis might be given also a real economy interpretation.

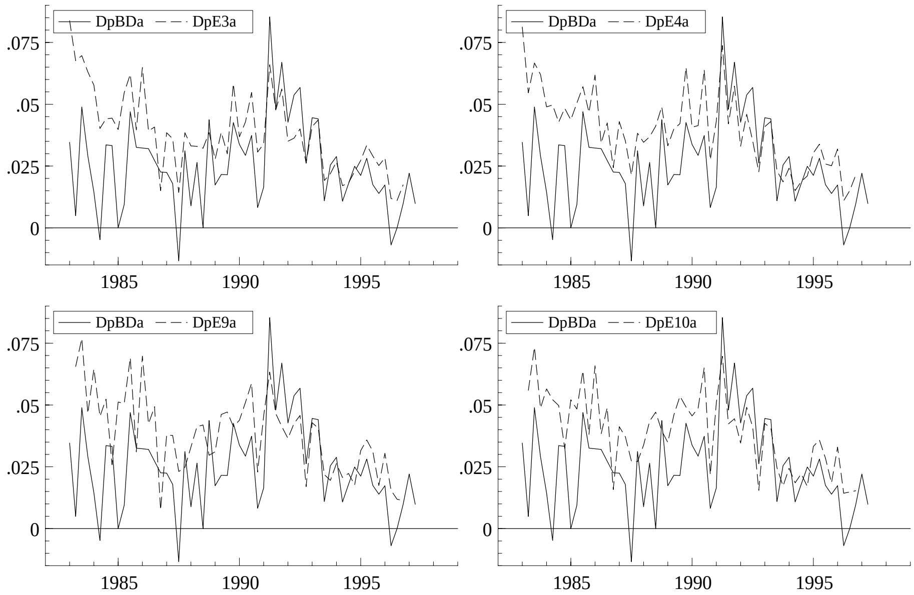

Figure 3: Annualized German (—–) and weighted area-wide inflation (- - -)

money balances for the four areas. Again of particular interest is the behaviour of the growth rates at the ERM crisis. Note the simultaneous drop in both rates when UK is included in the area (E4, E10) but the much stronger drop of real GDP growth compared with real balances in E3. In E9 the GDP growth rate is falling further in the fourth quarter whereas in all other area-specifications it recovers strongly after the sharp decline in the third quarter of 1992. I will come back to these observations further below when discussing the estimated models. The set of variables to be used in the European money demand models is now complete. For the four defined areas area-wide real money balances will be explained by area-wide real output, area-wide inflation, German short-term interest rates (three months money market rate), German long-term interest rates (yield on German public bonds outstanding), and the DM/US Dollar exchange rate. All series are quarterly data. The empirical econometric models are developed and presented in the next section.

4 Empirical estimation of European money demand models

For the estimation of the area-wide European money demand models I follow the same strategy as described in detail in Beyer (1998*b*, *c*) for the cointegration analysis and in Beyer (1998*a*) for the single equation estimation strategy.[3] In the first step the processes in levels are analyzed within the Johansen cointegration framework.

[3]For all estimations the software programs PcGive and PcFiml version 9.0 (see Doornik and Hendry, 1997) have been used.

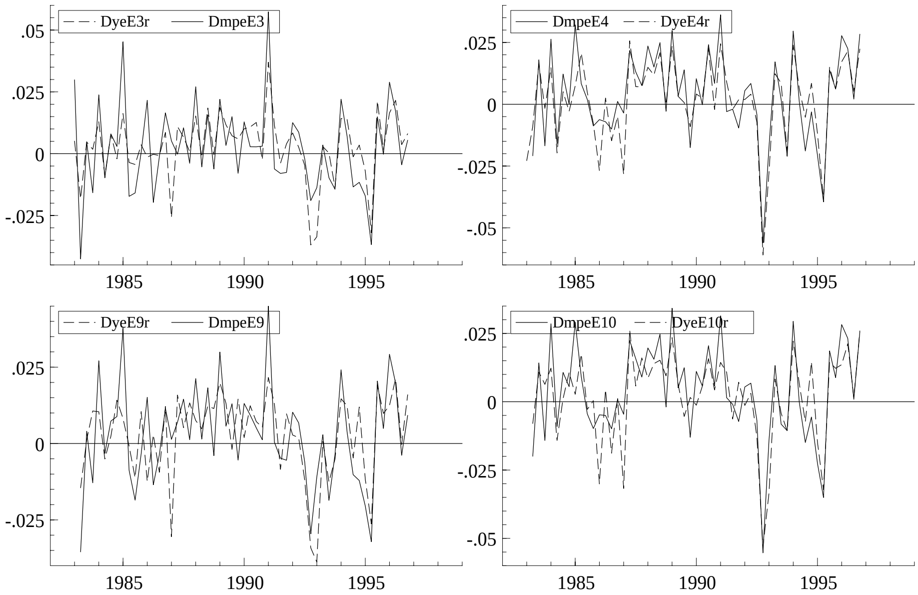

Figure 4: Growth rates of area-wide real GDP (- - -) and real money balances (——)

The aim is to establish an empirically stable cointegrating relationship which can be interpreted as a long-run money demand function. Then equilibrium correction models are estimated for each of the four areas followed by their statistical evaluation and economic interpretation.

4.1 Cointegration analysis

Starting point for the cointegration analysis is the formulation of a p-dimensional finite autoregressive representation for the process $X_t = \{(m-p)_t^{Ej}, y_t^{Ej}, \Delta p_t^{Ej}, RM_t, RB_t, ex_t\}$ such that

$$X_t = \Pi_1 X_{t-i} + \Pi_2 X_{t-2} + ... + \Pi_k X_{t-k} + \Phi D_t + \epsilon_t, t = 1, ..., T \tag{7}$$

where p is the number of variables under consideration. It is assumed that $\{\epsilon_t\}$ is a sequence of independent Gaussian variables with zero mean and covariance matrix Ω. D_t contains for all areas the impulse Dummies DP91(1), DP91(2), DP92(3) which are unity in the corresponding period and zero elsewhere. They capture German unification and the ERM-crisis. With respect to the cointegration space they enter the model unrestricted (see Beyer (1998*b*) for a discussion on deterministic variables in cointegrating processes). Equation (7) can then be reparameterized as an observational equivalent Vector Equilibrium-Correction Model (VEqCM)

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \Phi D_t + \epsilon_t \tag{8}$$

H_0	95% critical value[b]	E3	E4	E9	E10
		Trace test statistics on the significance of the eigenvalues[a,c]			
$r \leq 0$	98,43{114.9}	117.8^{*}_{++}(0.51)	103.9_{+} (0.48)	148.7^{**}_{++}(0.67)	122.8^{*}_{++}(0.52)
$r \leq 1$	71.94{87.3}	78.61_{++} (0.45)	67.89 (0.43)	89.69^{*}_{++}(0.49)	83.62_{++} (0.49)
$r \leq 2$	49.04{63.0}	45.85 (0.33)	36.93 (0.27)	53.45_{+} (0.37)	47.51 (0.38)
$r \leq 3$	28.90{42.4}	23.54 (0.19)	19.32 (0.18)	28.35 (0.21)	21.36 (0.20)
$r \leq 4$	19.60{25.3}	12.1 (0.15)	8.36 (0.12)	15.5 (0.19)	8.94 (0.13)
$r \leq 5$	n.a. {12.3}	3.1 (0.05)	1.11 (0.02)	4.21 (0.07)	1.28 (0.02)

[a] estimated eigenvalues in round brackets
[b] critical values simulated with DisCo. Unrestricted: Dummies DP91(1) (not in $r \leq 4, 5$), DP92(3) (not in $r \leq 5$), and a Constant; Restricted: linear trend.
For corresponding T=54, 10000 repetitions. PcFiml's critical values in {}.
[c] 95% and 99% significance: $_{+,++}$ w.r.t. simulated cv and *,** w.r.t. PcFiml

Table 4: Testing for the dimension of the cointegrating space

where $\Pi = \sum_{i=1}^{k} \Pi_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{k} \Pi_j$. To exclude explosive roots it is assumed that the characteristic polynomial

$$A(z) = I - \sum_{i=1}^{k} \Pi_i z^i \tag{9}$$

satisfies the condition that if $|A(z)| = 0$, then either $|z| > 1$ or $z = 1$.

To estimate the dimension of the cointegration space the analysis in Beyer (1998*b*) shows that the critical values of the trace statistics differ remarkably when deterministic variables such as dummies are specified in the model. For the models under consideration here (i.e. 56 observations for the sample period 1983.1-1996-4) I have used the simulation program DisCo (version 1.4, see Johansen and Nielsen, 1997) to simulate critical values when DP91(1), DP92(3) and the constant are unrestricted and a linear trend is restricted to lie in the cointegration space.[4] The results are presented in Table 4. Similar to the application in Beyer (1998*b*) also here different conclusions about the dimension of the cointegration space are drawn, depending on which critical values are used. Based on the simulated ones generated in this paper the null hypothesis of no cointegration is rejected for all areas. For E9 and E10 however, there might be a second cointegrating vector and for E9 even a third one is probable. Nevertheless here I assume the existence of only one cointegrating vector but as it has with Beyer's (1998*a*) analysis on German money demand, further research might establish a higher dimension of the cointegration space also for this data set. Before the estimation of the cointegrating vector for each area is pursued the variables are tested for being I(0) by formulating a cointegrating vector with unity coefficient imposed on the variable under consideration and zero coefficients elsewhere. For *RM*

[4] DisCo is limited to operate with no more than three unrestricted deterministic variables, so one Dummy (DP91.2) had to be skipped.

	E3		E4		E9		E10	
	$\chi^2(6)$	$\chi^2(5)$TS	$\chi^2(6)$	$\chi^2(5)$TS	$\chi^2(6)$	$\chi^2(5)$TS	$\chi^2(6)$	$\chi^2(5)$TS
$(m-p)^{Ej}$	34.2	25.6	30.5	25.0	51.6	48.1	33.6	27.7
y^{Ej}	36.1	37.3	29.9	24.0	54.4	47.1	34.4	25.1
Δp^{Ej}	25.6	20.1	22.6	13.1*	42.1	38.6	19.5	14.5*
ex	36.9	20.5	33.6	19.0	54.1	42.7	34.9	21.7

Table 5: Test statistics for testing individual variables to be I(0)

and RB this has been rejected in Beyer (1998c) so Table 5 presents only results of $(m-p)^{Ej}$, y^{Ej}, Δp^{Ej} and ex. All variables have been tested also for trend stationarity (TS) by including a linear trend in the cointegration space and leaving its coefficient unrestricted. For all variables the null hypothesis of being I(0) is strongly rejected (only inflation in E4 and E10 have p-values of around 1% for trend-stationarity)[5]. Hence, for all variables it is assumed that they are I(1). After restricting the rank of the long run cointegration matrix $\Pi = \alpha\beta'$ to be unity the single cointegrating vector β' for each area is estimated with the trend- coefficient being restricted to zero. The results in Table 6 show the estimated coefficients and their standard errors. The column headed $\alpha \neq 0$ specifies the variables for which evidence of weak exogeneity with respect to the (single) cointegrating vector was rather weak (inflation in the E10 area and short-term rates in the E4 area) so they have been left unrestricted in the system when estimating the coefficients of β. This evidence was judged by the sensitivity of the $\chi^2(\nu)$ test statistic on the validity of the restrictions imposed on the parameters of the cointegration space. In addition to the zero restrictions on the α's and a zero trend coefficient unit income elasticity is imposed apart from the E3 area. In E3 income elasticity is significantly smaller than unity. A coefficient of 0.5 is imposed to allow for an interpretation along the Baumol-Tobin square-root-rule.[6] None of the $\chi^2(\nu)$ test statistics in Table 6 is significant at 1% and only the one for E4 is significant at 5%. Note that the same applies when only the β-restrictions are imposed without restricting α, yielding $\chi^2(2)$ test statistics of 3.65 [0.16] for E3, 8.08 [0.0176] for E4, 3.789 [0.15] for E9, and 0.471 [0.789] for E10. The empirical stability of the coefficients is shown by the graphs of Figures 5 - 8. They show the recursive estimates of the β coefficients with two standard deviation error-bands (see Hansen and Johansen, 1996 for technical details) and of the largest eigenvalue.

The cointegrating relationships are indeed consistent with an interpretation as long-run money demand equations with coefficients of the "right signs" and familiar magnitudes. Note that the coefficient on the DM/US Dollar exchange rate is negative for all areas. This allows for a standard currency substitution explanation (the stronger the nominal anchor currency of the area (i.e. the DM) the smaller ex and the higher the demand for area-wide real money balances). When in the E10 system also $\alpha_{\Delta\Delta p}$ is restricted to be zero the estimated coefficients of the cointegrating

[5] Note that testing the exchange rate variable in all areas is redundant but has been done as a consistency check.

[6] This does not apply when leaving UK out of E10: For E9 testing for an income elasticity of 0.5 is strongly rejected. Nevertheless, when freely estimated, the income elasticity of $(m-p)^{E9}$ is 0.9.

$(m-p)^{Ej}$	Estimated cointegrating relationships (standard errors in round brackets)[a] y^{Ej}	Δp^{Ej}	RB	RM	ex	$\alpha \neq 0$	$\chi^2(\nu)$
E10	**1**	-2.374	-1.233	1.767	-0.074	$\Delta(m-p)$	(6) 9.35
	(-)	(0.71)	(0.54)	(0.27)	(0.01)	$\Delta\Delta p$	[0.154]
E9	**1**	-0.731	-1.840	1.231	-0.026	$\Delta(m-p)$	(7) 12.82
	(-)	(0.13)	(0.20)	(0.10)	(0.007)		[0.076]
E4	**1**	-1.323	-2.193	1.989	-0.073	$\Delta(m-p)$	(6) 13.79
	(-)	(0.34)	(0.50)	(0.25)	(0.01)	ΔRM	[0.032]
E3	**0.5**	-1.777	-1.326	1.769	-0.037	$\Delta(m-p)$	(7) 11.63
	(-)	(0.26)	(0.39)	(0.19)	(0.01)		[0.113]

[a] The coefficient on the linear trend has been restricted to zero in all cases.

Table 6: Cointegrating relationships of European money demand

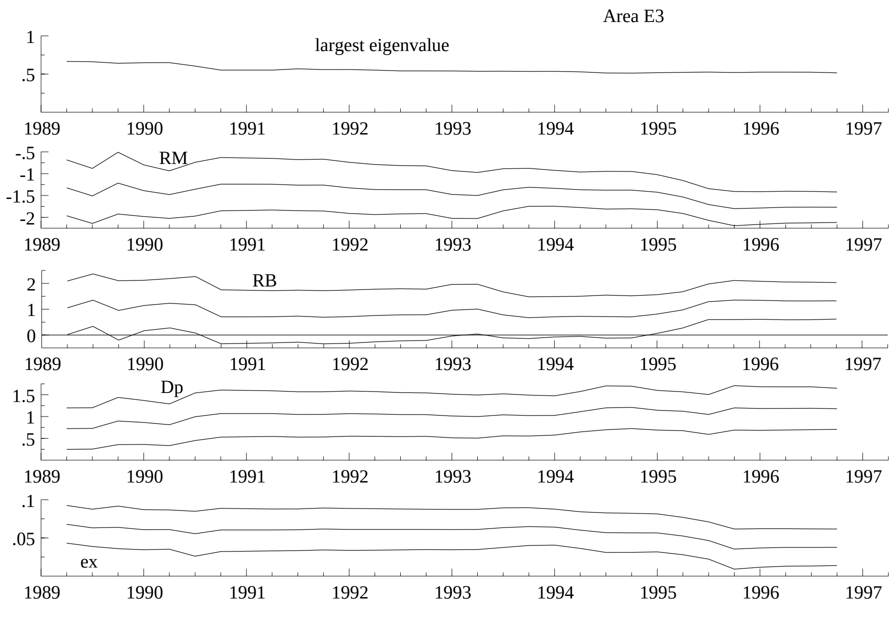

Figure 5: Recursive long run coefficients and largest eigenvalue for area E3

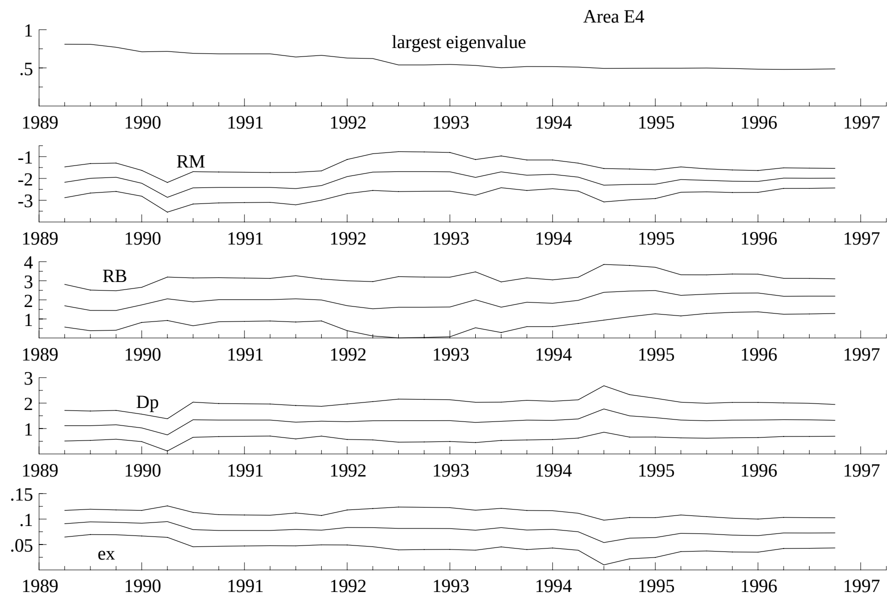

Figure 6: Recursive long run coefficients and largest eigenvalue for area E4

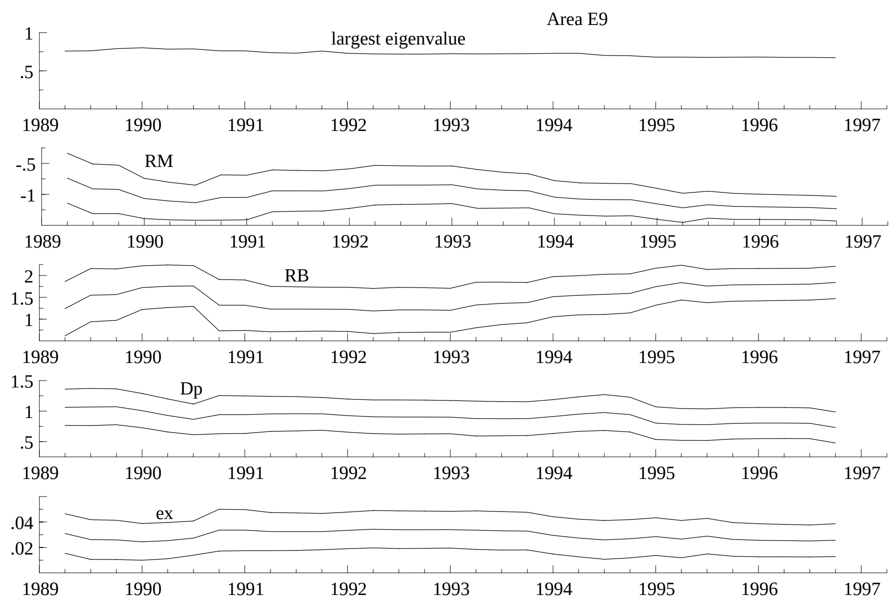

Figure 7: Recursive long run coefficients and largest eigenvalue for area E9

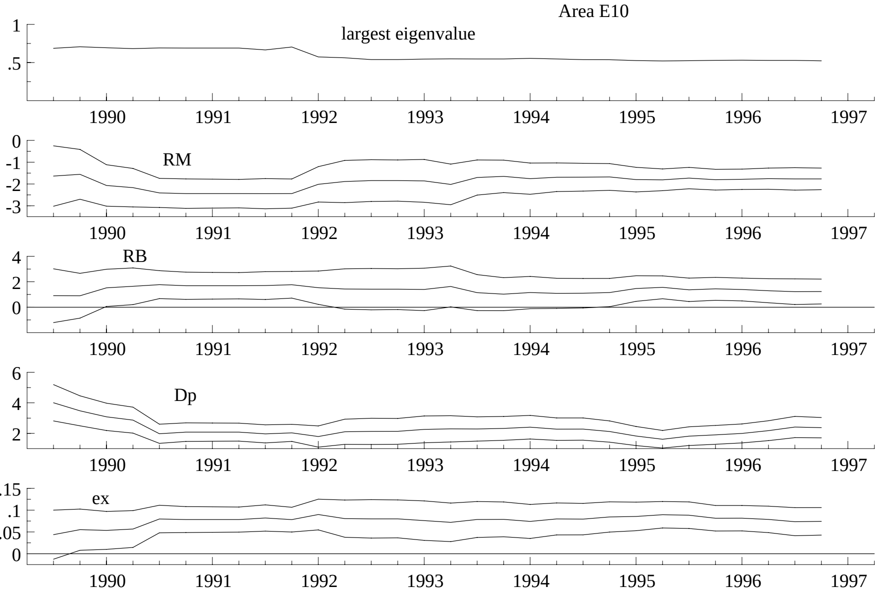

Figure 8: Recursive long run coefficients and largest eigenvalue for area E10

vector of $(m-p)^{E10}$ (for which then all explanatory variables are weakly exogenous) are even more similar to those of E9 (-1, 1, -0.71, -1.58, 0.71, -0.11). Since the p-value of the $\chi^2(7) = 15.56$ test statistic is only three percent when restricting also $\alpha_{\Delta\Delta p}$ and hence all alphas except $\alpha_{\Delta(m-p)}$ in the E10 system to be zero it has been tested whether in a simultaneously estimated two equation system of $\Delta(m-p)^{E10}$ and $\Delta\Delta p^{E10}$ the coefficient of the cointegrating vector can be restricted to be zero in the $\Delta\Delta p^{E10}$ equation. This has not been rejected such that a single equation technique for estimating a $\Delta(m-p)^{E10}$ model can be justified. Moreover, the contemporaneous variable of $\Delta\Delta p_t^{E10}$ is not significant in the $\Delta(m-p)^{E10}$ model. Hence in practice there is no danger with respect to a possible violation of non-weak exogeneity of the parameters of interest in the $\Delta(m-p)^{E10}$ model. The same was carried out and applies for RM in the E4 specification. The next step is then to estimate EqCMs for each of the four area-wide changes in real balances $\Delta(m-p)_t^{Ej}$.

4.2 Equilibrium Correction Models

Starting from a general EqCM for each area with four lags on each variable and the corresponding cointegration relationship CI^{Ej} specified as regressor

$$\begin{aligned}\Delta(m-p)_t^{Ej} &= \sum_{i=1}^{4}\Gamma_{1i}\Delta(m-p)_t^{Ej} + \sum_{i=0}^{4}\Gamma_{2i}\Delta y_t^{Ej} + \sum_{i=0}^{4}\Gamma_{3i}\Delta\Delta p_t^{Ej} + \sum_{i=0}^{4}\Gamma_{4i}\Delta RM_t \\ &\quad + \sum_{i=0}^{4}\Gamma_{5i}\Delta RB_t + \sum_{i=0}^{4}\Gamma_{6i}\Delta ex_t + \gamma(CI^{Ej})_{t-1} + \Phi D_t + \varepsilon_t \qquad (10)\end{aligned}$$

the equilibrium correction models (11) - (14) are obtained after sequential elimination of all insignificant regressors from (10)[7].

$$
\begin{aligned}
\Delta(m-p)_t^{E10} = \; & \underset{(0.0009)}{0.002} \; \underset{(0.032)}{+0.078\{\Delta(m-p)_{t-2}+\Delta(m-p)_{t-4}\}^{E10}} \; \underset{(0.060)}{+0.902\Delta y_t^{E10}} \\
& \underset{(0.052)}{+0.265\Delta\Delta p_{t-4}^{E10}} \; \underset{(0.167)}{+0.497\Delta RM_{t-3}} \; \underset{(0.013)}{-0.046\Delta ex_{t-3}} \\
& \underset{(0.030)}{-0.197\{(m-p)-(m-p)^*\}_{t-1}^{E10}} \; \underset{(0.006)}{-0.02DP92(3)} \; \underset{(0.005)}{-0.02DP95(1)} \\
& R^2 = 0.91;\; \sigma = 0.0057;\; RSS = 0.00133;\; T = 1984(3) - 1996(4)
\end{aligned} \tag{11}
$$

$$
\begin{aligned}
\Delta(m-p)_t^{E9} = \; & \underset{(0.0007)}{0.002} \; \underset{(0.053)}{+0.39\Delta(m-p)_{t-4}^{E9}} \; \underset{(0.050)}{+0.859\Delta y_t^{E9}} \; \underset{(0.062)}{-0.350\Delta y_{t-4}^{E9}} \; \underset{(0.152)}{-0.479\Delta RM_t} \\
& \underset{(0.109)}{+0.516\{\Delta RB_{t-2}+\Delta RB_{t-3}\}} \; \underset{(0.008)}{+0.057\{\Delta ex_t+\Delta ex_{t-1}\}} \; \underset{(0.010)}{-0.042\Delta ex_{t-3}} \\
& \underset{(0.044)}{-0.505\{(m-p)-(m-p)^*\}_{t-1}^{E9}} \\
& \underset{(0.004)}{+0.013DP91(1)} \; \underset{(0.004)}{-0.014DP91(2)} \; \underset{(0.005)}{-0.02DP95(1)} \\
& R^2 = 0.94;\; \sigma = 0.00437;\; RSS = 0.000746;\; T = 1984(2) - 1996(4)
\end{aligned} \tag{12}
$$

$$
\begin{aligned}
\Delta(m-p)_t^{E4} = \; & \underset{(0.0007)}{0.003} \; \underset{(0.052)}{+0.814\Delta y_t^{E4}} \; \underset{(0.037)}{+0.215\{\Delta y_{t-1}+\Delta y_{t-3}\}^{E4}} \; \underset{(0.059)}{+0.268\Delta\Delta p_{t-1}^{E4}} \\
& \underset{(0.132)}{+0.524\Delta RM_{t-3}} \; \underset{(0.119)}{-0.437\{\Delta RB_t-\Delta RB_{t-2}\}} \; \underset{(0.010)}{+0.063\{\Delta ex_t-\Delta ex_{t-3}\}} \\
& \underset{(0.042)}{-0.363\{(m-p)-(m-p)^*\}_{t-1}^{E4}} \\
& \underset{(0.005)}{+0.02DP91(1)} \; \underset{(0.005)}{-0.03DP91(2)} \; \underset{(0.006)}{-0.023DP92(3)} \; \underset{(0.004)}{-0.02DP95(1)} \\
& R^2 = 0.95;\; \sigma = 0.00454;\; RSS = 0.00078;\; T = 1984(3) - 1996(4)
\end{aligned} \tag{13}
$$

$$
\begin{aligned}
\Delta(m-p)_t^{E3} = \; & \underset{(0.001)}{0.001} \; \underset{(0.077)}{+0.304\Delta(m-p)_{t-4}^{E3}} \; \underset{(0.099)}{+0.909\Delta y_t^{E3}} \; \underset{(0.090)}{-0.191\Delta\Delta p_{t-3}^{E3}} \\
& \underset{(0.030)}{-0.171\{(m-p)-(m-p)^*\}_{t-1}^{E3}} \\
& \underset{(0.009)}{+0.024DP91(1)} \; \underset{(0.008)}{-0.02DP95(1)} \\
& R^2 = 0.78;\; \sigma = 0.0085;\; RSS = 0.00312;\; T = 1984(3) - 1996(4)
\end{aligned} \tag{14}
$$

	E3	E4	E9	E10
AR $(1-4)$	1.52[0.21]	0.40[0.80]	0.94[0.45]	1.12[0.35]
Distribution	F(4,39)	$F(4,34)$	$F(4,35)$	$F(4,37)$
$ARCH$ 4	0.21[0.92]	2.10[0.10]	0.93[0.45]	0.55[0.69]
Distribution	$F(4,35)$	$F(4,30)$	$F(4,31)$	$F(4,33)$
X_i^2	0.43[0.91]	0.27[0.99]	0.91[0.58]	0.51[0.90]
Distribution	$F(10,32)$	$F(18,19)$	$F(19,19)$	$F(14,26)$
$RESET$	5.19[0.03]	0.38[0.53]	0.14[0.70]	1.37[0.24]
Distribution	$F(1,42)$	$F(1,37)$	$F(1,38)$	$F(1,40)$
$Normality$	3.30[0.19]	2.22[0.32]	0.99[0.60]	2.38[0.30]
Distribution	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$

Table 7: Statistical Evaluation of European Money Demand Models

4.3 Statistical Evaluation

For the statistical evaluation of the four models Table 7 summarizes the tests on misspecification as provided by PcFiml. Each model passes the tests on non-autocorrelation, no-ARCH, functional form (linearity) and normality of their residuals. Only the RESET test for the E3 model is significant at five percent. Actual and fitted values for the models are shown in Figure 9.

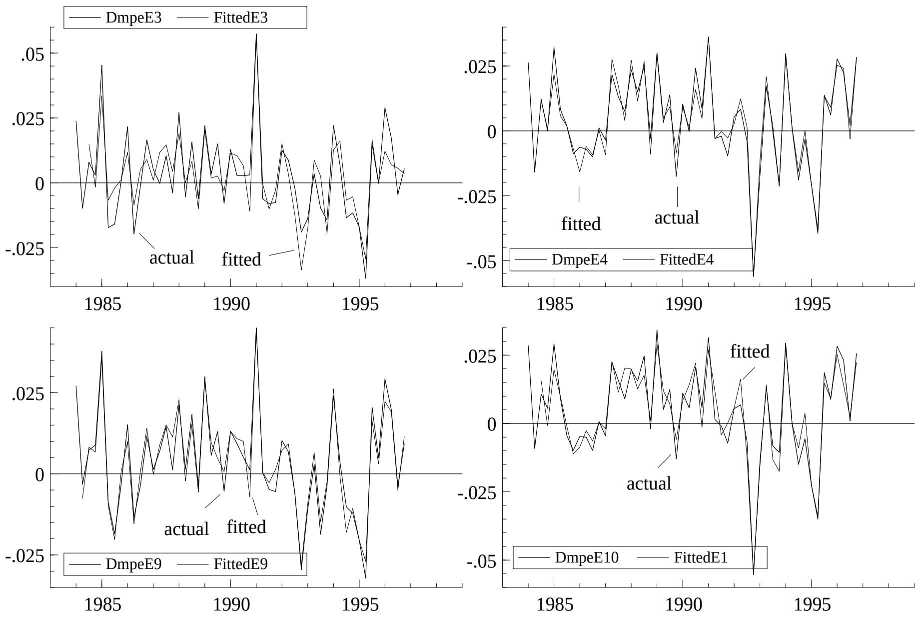

Figure 9: Actual and fitted values of (clockwise) area-wide E3, E4, E10 and E9 models

All four models are capable to predict the major in-sample dynamics of real money balances. Apart from the highly parsimonious E3 model the standard errors of the

[7] To ensure normality of the residuals the impulse dummy DP95(1) was included in D_t as well.

area-wide money demand models are smaller than those of the German money demand model. They are 0.67% in Beyer's (1998a) single equation model and 0.9% in the simultaneous equations model in Beyer (1998c), compared with 0.45, 0.44 and 0.57% in the E4, E9 and E10 models, respectively. Even the 0.85% standard error of the E3 model is lower than the one in the German simultaneous equations model. This confirms the findings of earlier studies that standard errors of area-wide models are tendencially lower than those of national money demand models. With regard to the cost and benefit discussion above this might be interpreted as a benefit from estimating area-wide money demand models. Figures 10 - 13 show the recursive graphs for models (11) - (14). In each Figure the recursive estimates of the coefficients are shown in the first two rows. For all four models they are empirically stable over time. This is true in particular for each of the equilibrium correction coefficients which are shown by the last graph in the second row. The recursive t-values in rows 3 and 4 confirm the significance of each regressor over time, and in particular of the EqCM coefficients. Row 5 finally presents the residuals with plus and minus two standard error bands showing again no signs of misspecification of any of the four models. The last two graphs in row 5 show the recursive one-step and N-step "Chow"-tests for structural breaks. Only once for the E3 and E9 model is the one step "Chow"-test significant at five percent. Hence, there is strong evidence that area-wide money demand for the four defined aggregates is empirically stable over time and that models (11) - (14) represent valid conditional distributions for area-wide monetary aggregates.

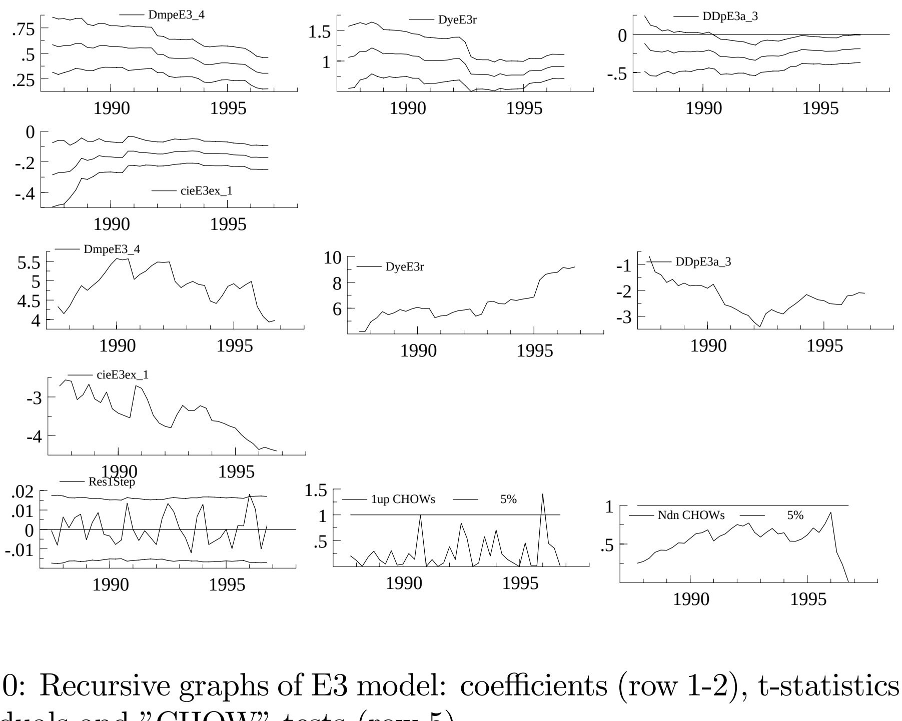

Figure 10: Recursive graphs of E3 model: coefficients (row 1-2), t-statistics (row 3-4), and residuals and "CHOW"-tests (row 5)

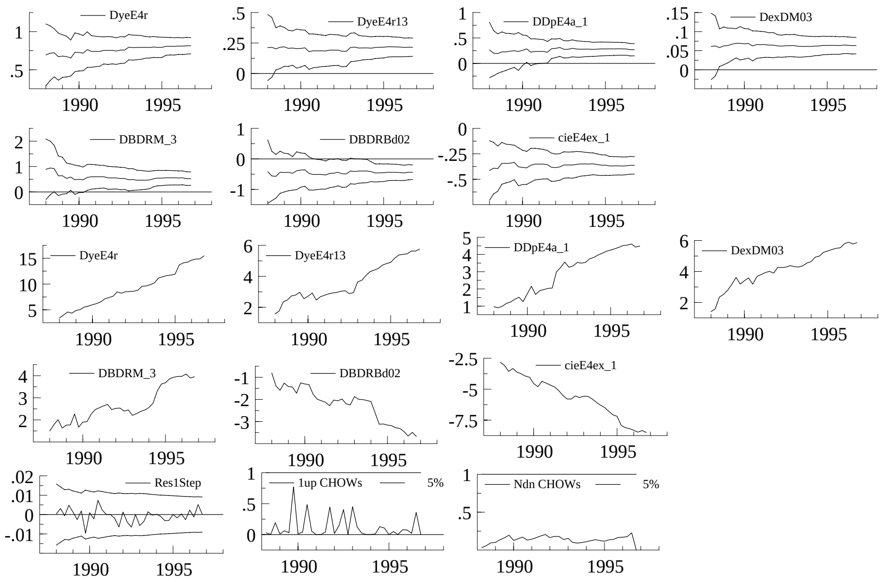

Figure 11: Recursive graphs of E4 model: coefficients (row 1-2), t-statistics (row 3-4), and residuals and "CHOW"-tests (row 5)

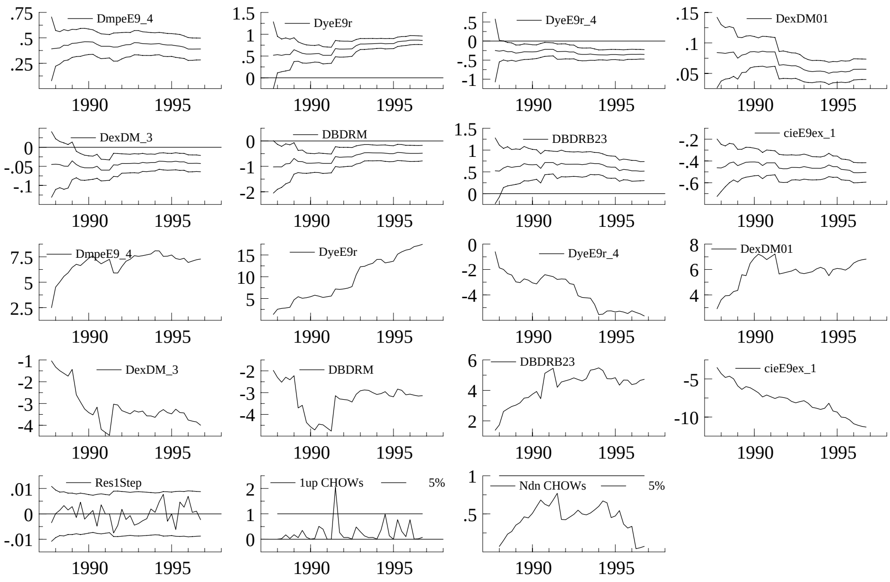

Figure 12: Recursive graphs of E9 model: coefficients (row 1-2), t-statistics (row 3-4), and residuals and "CHOW"-tests (row 5)

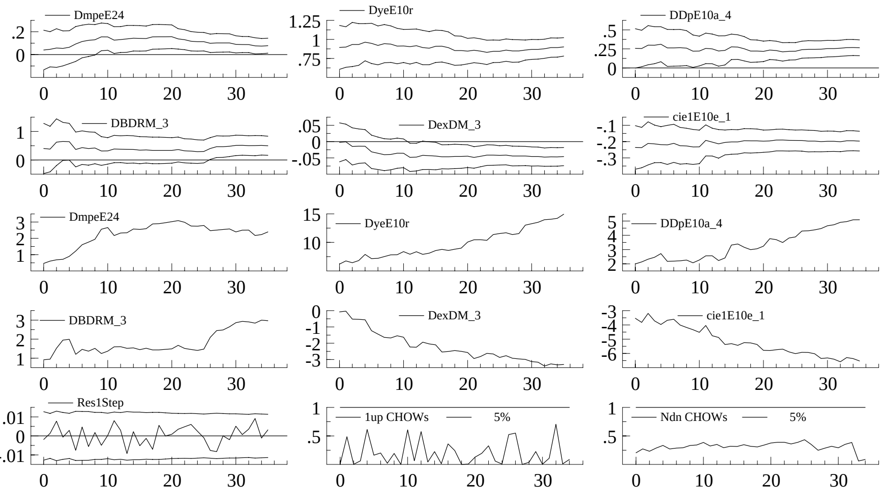

Figure 13: Recursive graphs of E10 model: coefficients (row 1-2), t-statistics (row 3-4), and residuals and "CHOW"-tests (row 5)

5 Economic interpretation of the empirical models and testing for super exogeneity

One of the most important issues for the conduct of monetary policy with regard to the properties of money demand models is whether they are empirically stable. From the statistical evaluation this can be established for the four different areas under consideration in this paper. Hence, an important economic implication is that stability per se might not be affected by size and composition of the monetary union, at least with regard to the role of the UK. There are similar features across the different area-specifications as well as remarkable differences. A property shared by all equations is that the coefficients of contemporaneous changes of area-wide GDP are highly significant and close to unity in all models. This suggests that unit-income homogeneity is almost fulfilled even in the short run. The EqCM coefficients in the estimated models are tendencially bigger in absolute value than those of national money demand models. For German money demand e.g. the coefficient is -0.08 in the single equation model of Beyer (1998*a*) and -0.033 in the simultaneous equations model in Beyer (1998*c*). Interestingly, the equilibrium correction of the E9 aggregate (when UK is left out of the E10 aggregate) within one period is more than twice as fast as for E10 with the absolute value of the equilibrium correction coefficient increasing from 0.2 to 0.5. On the other hand when UK is dropped from the E4 aggregate long-run income elasticity reduces from 1 to 0.5 but the equilibrium correction of the E3 aggregate is much slower: The equilibrium correction coefficient *decreases* in absolute value from 0.36 to 0.17. With regard to the short-run dynamics there are important differences concerning both interest rates. In the E4 and E10 models the impact of changes in short-term interest rates is positive but it is negative in the E9 model. On the other hand the impact of changes in long-term rates is positive for money demand in the E9 area but negative for that in E4 and in the E3 aggregate there is no impact at all from short run dynamics of interest rates on money demand. This suggests the conclusion that for the efficient use of short-term interest rates as monetary instruments the inclusion or exclusion of UK in the area does matter in the short-run. Turning to the role of inflation for money demand there is no such strong negative relationship as with German inflation and money demand which was found in the studies by Beyer (1998a,c). In the E10 and E4 area lags of changes in inflation have a positive impact on money demand whereas only in E3 a modest negative coefficient appears.

The next step is to investigate which impact regime shifts in explanatory variables (e.g. output shocks and shifts in control variables such as short-term interest rates) have on the different area-wide European money demand models. Of particular interest is whether similar conclusions as in Beyer's (1998a) German money demand study on the causal direction between money and prices apply also for aggregated European variables.

5.1 Area-wide money demand models and the Lucas Critique

A rather sceptical view on area-wide money demand models is articulated e.g. by Arnold (1994). In a cross-section study he finds that the empirical stability of area-wide money demand models is not positively related to the size of the currency area. Rather critically he concludes that estimated area-wide money demand models "overestimate money demand stability after unification". As reasons for this Arnold argues that since money demand instability is caused primarily by factors related to the financial system and monetary policy a monetary unification will lead to a centralization of these sources of instability. However, this might be more an empirical and econometric issue, strongly related to the Lucas Critique. Being an empirical case-issue this raises therefore doubts whether such a fundamental critique on estimating area-wide money demand models is indeed relevant. An econometric tool for testing whether or not an estimated model is subject to the Lucas critique is the concept of super exogeneity as defined by Engle, Hendry and Richard (1983). The test procedure is explained in Engle and Hendry (1993) and applied e.g. for the German money demand model in Beyer (1998a). In the next step tests for super exogeneity for some of the variables are carried out.

5.2 Testing for super exogeneity: The role of inflation, short-term interest rates and GDP

The result that inflation was super-exogenous with respect to money demand in Germany has raised doubts on the P-Star concept as pursued by the Bundesbank. Following Hoover (1991) and Beyer (1993) the argument put forward in Beyer (1998a)

is that a variable which is super-exogenous with respect to the intermediate target cannot be controlled by the intermediate target itself or by a procedure that aims to control the intermediate target in order to control super exogenous prices. A similar result can be found for inflation in the E10 and E4 areas. Looking at the properties of an autoregressive model for $\Delta\Delta p_t^{E10}$ recursive estimation reveals a parameter shift in the marginal distribution in the fourth quarter of 1990 and the second quarter of 1991. Impulse dummies DP90(4) and DP91(2) which are unity at those observations and zero elsewhere are significant in the $\Delta\Delta p_t^{E10}$ model with absolute t-values of 2.5 each. However, when added as regressors in (11) DP90(4) and DP92(2) are not significant having t-values of just over unity and 1.8. An F-test for adding them to (11) yields a test statistic of F(2,39) = 2.69 [0.08]. With regard to the marginal distribution of $\Delta\Delta p_t^{E4}$ there appear to be shifts in the fourth quarter of 1989 and in the first quarter of 1992. Corresponding dummy variables DP89(4) and DP92(1) are highly significant with t-values of 2.5 and 2.9 whereas when added into the E4 money demand model (13) they have t-values of only 0.7 and 1.6 and their joint-adding F-statistic is F(2, 40) = 1.6373 [0.21]. For the non-UK areas E3 and E9 super exogeneity with respect to the parameters of the corresponding money demand models is not at all rejected but it is hard to provide empirical evidence in favor of it since the marginal processes of inflation for those areas appear to be very stable. Moreover, short-run dynamics of inflation are not even represented as regressors in the $\Delta(m-p)_t^{E9}$ model (12). The economic implications of these findings are that for the areas which contain UK causality might not run from money to prices but from prices to money. Hence the same critique on the P-Star concept of the Bundesbank which depends on the causal direction from money to prices might hold with respect to an area-wide monetary policy.

Testing ΔRM_t for being super-exogenous with respect to the parameters of the E4, E9 and E10 money demand models yields strong evidence that short-term interest rates qualify as control variables to influence those monetary aggregates. The marginal distribution of ΔRM_t modelled as an AR(1) process (longer lags are insignificant) appears to be rather unstable with five significant breaks in 1985(4) 1987(2), 1988(1), 1988(3), 1993(2) and t-values of corresponding dummy variables being 1.95, 2.67, 3.06, 2.55, and 2.18. None of those dummies is significant in either of the money demand models and jointly adding yields F-statistics of F(5,35) = 0.30 [0.90] in (11); F(5,32) = 0.91 [0.4822] in (12) and F(5,32) = 0.92 [0.4756] in (13). However, these result should be interpreted carefully with respect to area-wide monetary policy of a future European Central Bank. What super exogeneity of German short-term interest rates with respect to area-wide European money demand does suggest is that the Bundesbank has influenced area-wide money demand by its monetary policy actions via changes in RM_t. There is furthermore strong evidence that there are no feedbacks from E4, E9 and E10 area-wide money demand onto the Bundesbank's decisions on RM_t. Granger-Causality tests for adding lagged real money balances of those three areas to an autoregressive model for ΔRM_t are not significant with F(5,41) test statistics of 1.78 [0.14] for $\Delta(m-p)^{E10}$; 1.88 [0.12] for $\Delta(m-p)^{E9}$; and 1.56 [0.19] for $\Delta(m-p)^{E4}$.[8] Hence, feedback-rules which would predict the path of

[8]Interestingly, for $\Delta(m-p)^{E3}$ the Granger-Causality teststatistic is significant at five percent

German short-term rates as being determined by area-wide European money balances might be considered as unlikely and this provides once again evidence in favor of the asymmetric functioning of the EMS in the post-83 period. It contrasts sharply with the German "domestic" feedback rule for exactly the same ΔRM_t variable presented in Beyer (1998*c*). To rule out such a feedback rule for a future ECB would however be a wrong conclusion to be drawn from these results. This to analyze would require a model for the "proper" European interest rate under control of the ECB. Data for this investigation will obviously only be available after the ECB will have started to operate and obviously a weighted average of European interest rates would not be a satisfactory substitute either.

Finally, when comparing the E10 and E9 models (11) and (12) it is noteworthy that the German unification dummy is not significant in the E10 model (t-value 0.85) but it is highly significant in the E9 model. Furthermore, the ERM-crisis-dummy DP92(3) is highly significant in both aggregates containing UK but not significant when UK is dropped. Since Italy whose currency left the ERM as well as the British Pound is present in all specifications this might suggest that the UK's impact on an area-wide monetary aggregate during the ERM crisis was much stronger than that of Italy. In all marginal models for Δy_t^{Ej} there is a huge break in the third quarter of 1992 and the ERM-crisis dummy D92(3) is highly significant. However, the marginal models do not show a break around German unification. With DP92(3) being highly significant in the $\Delta(m-p)^{E10}$ and $\Delta(m-p)^{E4}$ models super exogeneity of area-wide GDP with respect to money demand is rejected when UK is included in the area. On the other hand super exogeneity for Δy_t^{E3} and Δy_t^{E9} with respect to the corresponding money demand models holds, i.e. when the UK is left out. This implies that money demand models for area-wide aggregates excluding UK might be very robust with respect to shifts caused by output shocks. This might be a good perspective for the monetary policy of the ECB in its starting period in which the UK will most probably not be a member of the monetary union.

Summing up the super exogeneity results, the coefficients of all four area-wide money demand models are empirically stable over time even though there have been parameter shifts in the marginal distributions of some of the explanatory variables. Hence a necessary condition for the Lucas critique not to apply for area-wide European money demand after EMU appears to be fulfilled.

6 Conclusions

In this paper empirical econometric money demand models for area-wide European aggregates of broad money are estimated, evaluated and interpreted. To investigate the impact of UK's inclusion or exclusion from EMU four different areas are defined for which empirically stable money demand models are presented. The stability of area-wide European money demand models is not affected by including UK, neither

(2.81 [0.023]). This suggests for future research to investigate further whether there are feedbacks from monetary conditions of a small area onto the Bundesbank's decisions on ΔRM_t which are "washed-out" when UK money balances are added to the aggregate.

to a group of nine countries nor to the three other countries of the "Big Four". Nevertheless, the different models obtained provide evidence that their short-term characteristics and economic implications *are* influenced by the participation or absence of UK from EMU. This might imply different monetary transmission mechanisms for the monetary policy actions of the ECB. For ECB policymakers this is important news because UK's joining at a later time after the starting period of EMU might either induce a shift of the short run parameters of the area-wide money demand function without necessarily destabilizing money demand permanently. Or it has no impact at all on money demand but might induce severe distortions of the monetary transmission mechanism. A possible scenario could be for example that up to UK's joining monetary targeting was efficiently conducted by using short-term interest rates but that the same monetary policy strategies fail to be successful after UK's joining. Hence, an issue for future research is to investigate the properties of a money demand model when the extension of the area (e.g. by the UK) is simulated *within* the sample period. This might provide further insight on the impact of UK's later joining to EMU. Whatever "tool-box" of monetary instruments and operating rules will be decided for the future European Central Bank to use, the effects of its monetary policy both in countries which join the EMU and in those which do not will depend on the transmission mechanisms of monetary policy in those countries. The different properties of money demand models with regard to inclusion or exclusion of the UK might be seen as further evidence for a different monetary transmission mechanism in the UK compared with other European economies. Future research might shed light into these differences because explaining and understanding them is crucial to understanding and forecasting the effects the ECB's monetary policy.

The optimistic message from this paper's area-wide European money demand models with regard to EMU is that for different areas empirically stable money demand functions exist with very similar long-run properties regardless on the composition the area. Artis *et al.* conclude their 1993 analysis on European money demand rather pessimistically that *"there must be a nagging doubt that underlying this apparently stable relationship are aspects of the Lucas critique and Goodhart's law which are simply waiting to have a further laugh at the expense of monetary economists."* The extensive investigation on parameter stability and super exogeneity in this paper leads to a more optimistic conclusion: At least a necessary condition for the Lucas critique not to apply for area- wide European money demand after EMU has not been rejected.

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Appendix

The Data

All data are quarterly. Both German interest rates are from DATASTREAM. The **German short-term rate** RM (GERMDRQ) is the 3 Month Money Market interest rate; and the **German long-term rate** RB (DBFEDBD) are yields on public bonds outstanding. All other data are from the EcoWin database, CRM Treasury Systems, Gothenburg (Sweden). For the monetary aggregates, output, goods prices (all mostly seasonally adjusted), interest rates and exchange rates the following quarterly series have been used: for the **broad monetary aggregates** the series 12060 (M3) except DK 12050 (M2); ESP 12050 (M3); FIN 12050 (M2, nsa); UK 12065 (M4); ITA 12055 (M2); NL 12050 (M3); for **output** the series 01020 (real GDP) except DK 01021 (nsa); SWE 01005 (nsa); FIN 01021 (nsa); for **goods prices** the series 01025 (GDP deflator) where DK, SWE and FIN series are nsa; for **bond yields** the series 14020 (10 year bonds) except BEL, DK, FIN, SWE (all 5 year bonds); for **exchange rates** the series 19005 (all US Dollar rates converted in DM rates by cross parities.